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REM.—A less developed form of the preceding but easily separated from it by its smaller size, pluripapillate leaf-cells, shorter pedicel, shorter and broader capsule and imperfect cilia. The leaves are usually not so abruptly contracted above the base, broadly ovate-lanceolate, the margins not rugose.

Comparisons kindly made by Mr. Gepp, of the British Museum, verify the statement of Renauld & Cardot\* as to the identity of *Hypnum ramulosum* Hpe. and *H. crispifolium* Hook., the types of both being unipapillate. The type of *Leskea laxifolia* Hook. (*H. laxifolium* Schwaeg.), loaned Mrs. Britton by the authorities at Kew, is *Brachythecium reflexum* (W. & M.) Br. & Sch.

ROSEMONT, N. J.

## Mesophyl of Ferns.

BY MARY ELGIN GLOSS.

While making a comparative study of the chlorophyl bearing cells of plants, including ferns, I noticed what appeared to me to be a marked resemblance between the sections of the leaves of two species of *Adiantum*. As some species of *Nephrolepis*, *Dryopteris*, and *Polypodium* show also peculiarities of structure characteristic of each genus, I have tabulated the results of observations made from February to May, 1897.

A study of the mesophyl of ferns made from material from the greenhouses near Evanston, and from the Missouri Botanical Garden, affords some characteristic differences and resemblances. In the species studied these seem to give a means of distinguishing one genus from another, as the presence of chlorophyl in the epidermis, the form and arrangement of the cells of the mesophyl, the size of the air spaces, the number of cells in thickness of the mesophyl, the presence of palisade tissue, and the number of cells in its depth, seem to be constant through a genus.

Species were examined from the following genera: *Adiantum*, *Dryopteris*, *Asplenium*, *Nephrodium*, *Nephrolepis*, *Polypodium*, *Pteris*, *Scolopendrium*, and *Blechnum*. The sections were cut perpendicular to the smaller veins of the fresh frond, and the comparison

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\* Musc. Am. Sept. 50. 1892.

made of parts midway between two well developed fibro-vascular bundles.

In five species of *Adiantum* I found no palisade tissue. The cells of both upper and lower epidermis contain chlorophyl. The cells of the upper epidermis are irregular in shape toward their lower side, extending down into the mesophyl. The air spaces are relatively large and numerous. The number of cells in thickness of the mesophyl is two. I examined six species of *Dryopteris* and found a palisade tissue of two layers of cells, sometimes arranged perpendicular to the epidermis. Both layers of the epidermis contain chlorophyl. The cells of the upper are sometimes irregular in shape, where the palisade tissue is not arranged with its longer axis perpendicular to the epidermis as in *A. tripterion*. The air spaces are very large, extending through a depth of two or even three cells. There are small air spaces all through the palisade tissue. The number of layers of cells of the mesophyl is five.

In seven species of *Nephrolepis* the layers of palisade cells have their longer axes parallel to the epidermis. There is no chlorophyl in the epidermis except in *N. molle*. There are a few small air spaces in the palisade layers, while the air spaces directly over the stomata are not deeper than one cell, and in each case are covered by one long cell or the protrusions of two. The cells of the spongy parenchyma are about twice as long as the palisade cells and lie parallel to them. The number of layers in the mesophyl is six, except *N. molle* which has two, and *N. Phillipinensis*, five.

Three species of *Polypodium* have a palisade tissue of two layers of cells. There is no chlorophyl in the epidermis, almost no air spaces in the upper layers and very large spaces below, often extending to the upper layer. There is no sharp distinction between the upper and lower layers of cells in shape and size. The number of layers of cells in the mesophyl is four.

In eight species of *Pteris* there is a palisade tissue of one layer, in *P. Cretica* of three layers. In four species chlorophyl is present in the epidermis, and in four there is no chlorophyl in the epidermis. The air spaces are very large and numerous. The cells of the lower layers of the mesophyl are sinuous and very irregular in shape and size. The number of layers of cells in the

depth of the mesophyl is from four to six, except in *P. cretica* which has ten.

*Scolopendrium* has no palisade tissue ; has chlorophyl in the epidermis ; has many large air spaces and irregularly shaped cells ; and nine layers of cells in the mesophyl.

Sachs says, " According to Stahl the palisade cells constitute that form of assimilating tissue, which is especially produced by intense light striking the leaf directly, and leaves grown in the shade produce chiefly or only spongy parenchyma." In the ferns I have examined the form of the cells of the mesophyl does not seem to depend on the intensity of the light, as most ferns grow naturally in diffuse light and the cultivated species which I have sed were grown in the shade. In some of these ferns a marked palisade structure is apparent as in *Dryopteris falcata* where it consists of two layers of cells, of rectangular section ; *Pteris aquilina* has also two layers ; *Pteris sagittifolia* has one layer ; *Pteris Cretica*, three and *Blechnum serrulatum*, two. Intermediate between this evident palisade structure and none at all, I find some which have one or more layers of closely placed cylindrical cells, with axes nearly equal. *Polypodium aureum* has two layers of these cells. *Polypodium vulgare*, grown in bright sunlight, and *Nephrolepis exaltata* have also two layers. *Dryopteris Mexicana*, *D. Filix-mas*, *Asplenium fabianum*, *Pteris serrulata*, and all the five species of *Adiantum* which I examined have no palisade parenchyma. The palisade tissue could not have been formed by intense sunlight, but rather it seems that the presence or absence of palisade parenchyma is very nearly constant throughout each genus, that is, it is a generic characteristic.

The ferns which have no palisade cells possess chlorophyl in the epidermis. It may be that this chlorophyl in the upper epidermis takes the place of a palisade layer. Terlitaki in a paper on *Struthiopteris* and *Pteris* says that ferns are distinguished by the presence of chlorophyl in the epidermis. Many of the ferns which I examined had chlorophyl in the epidermis layers, as the genus *Dryopteris*, which had also a palisade tissue, and four species of *Pteris*, *Blechnum serrulatum*, *Scolopendrium* and *Asplenium*. There are, however, many which have no chlorophyl in the epidermis, as the genus *Nephrolepis*, *Polypodium* and four species of *Pteris*. These have without exception a palisade structure.

From the species I have examined it appears, first, that in any one genus the number of cells in thickness of the mesophyll is constant; *Adiantum*, 2; *Dryopteris*, 5; *Nephrolepis*, 6; *Polypodium* 4. Second, the presence of chlorophyll in the epidermis is characteristic of a genus. *Adiantum* and *Dryopteris* possess chlorophyll in epidermis and *Nephrolepis* and *Polypodium* do not. Third, the relative size and shape of the air spaces is constant throughout a genus. Fourth, the shape and arrangement of the cells are somewhat constant. Fifth, the presence of palisade tissue and the number of cells in its depth are constant through a genus.

These characteristics taken one with the other appear to form a means sufficient to distinguish one genus from another.

	No. Cells in Mesophyll	No. Cells in Palisade	Depth of Frond	Chlor. in Epidermis	Air Spaces
<i>Adiantum</i>					
<i>Capillus-veneris</i>	2	0	106	Chlor.	Large
<i>tenerum</i>	2	0	77	Chlor.	Large
<i>pedatum</i>	2	0	70	Chlor.	Large
<i>trifidum</i>	2	0	77	Chlor.	Large
<i>Nephrolepis</i>					
<i>molle</i>	2	0	110	Chlor.	Small, very
<i>Phillipinensi</i>	5	2	110	Chlor.	Small, 1 cell
<i>tuberosa</i>	6	2	198	No Chlor.	Small, 1 cell
<i>davalloides</i>	6	2	185	No Chlor.	Small, 1 cell
<i>Collengerii</i>	6	2	176	No Chlor.	Small, 1 cell
<i>exaltata</i>	6	2	176	No Chlor.	Small, 1-2 cells
<i>Polypodium</i>					
<i>aureum</i>	4	2	176	No Chlor.	Large, very
<i>vulgare</i>	4	2	198	No Chlor.	Large
<i>reptans</i>	4	2	132	No Chlor.	Large
<i>Dryopteris</i>					
<i>Mexicana</i>	5	2	171	Chlor.	Large, very
<i>Filix-mas</i>	5	2	146	Chlor.	Large, very
<i>Thelypteris</i>	5	2	143	Chlor.	Large, very
<i>triptera</i>	5	2	114	Chlor.	Large, very
<i>falcata</i>	6	2	440	Chlor.	Large, very

BOTANICAL LABORATORY, NORTHWESTERN UNIVERSITY,  
EVANSTON, ILL.